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The Global Energy Market:  
Comprehensive Strategies to Meet  
Geopolitical and Financial Risks



Energy, Financial Contagion, and the Dollar

Mahmoud Amin El-Gamal and Amy Myers Jaffe



THE JAMES A. BAKER III INSTITUTE FOR PUBLIC POLICY  
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THE GLOBAL ENERGY MARKET:  
COMPREHENSIVE STRATEGIES TO MEET GEOPOLITICAL  
AND FINANCIAL RISKS

*THE G8, ENERGY SECURITY, AND GLOBAL CLIMATE ISSUES*

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## ABOUT THE GLOBAL ENERGY MARKET STUDY

*The Global Energy Market: Comprehensive Strategies to Meet Geopolitical and Financial Risks—The G8, Energy Security, and Global Climate Issues* examines a variety of scenarios for the future of global energy markets. Some of these scenarios evaluate factors that could trigger a regional or worldwide energy crisis. The study assesses the geopolitical risks currently facing international energy markets and the global financial system. It also investigates the consequences that such risks could pose to energy security, pricing, and supply, as well as to the transparent and smooth operation of the global market for oil and natural gas trade and investment. By analyzing these threats in depth, the study identifies a series of policy frameworks that can be used to fortify the current market system and ensure that it can respond flexibly to the array of threats that might be encountered in the coming years. The study also looks at the impact of emerging climate policy on the future of world energy markets.

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**ENERGY, FINANCIAL CONTAGION,  
AND THE DOLLAR**

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## **I Executive Summary**

Most commentary on the current credit crisis in U.S. and global financial markets has focused on the role of China and other Asian creditors of the United States. In this paper, we focus on the effects of high oil prices on resurgent petrodollar flows, which have contributed to current economic conditions, including rising inflation levels worldwide, very similar to the ones prevailing in the 1970s. Unsustainable levels of U.S. debt, the magnitude of the current credit crisis, and the political and economic difficulty of raising interest rates to reverse those trends, suggest that the global economic and financial system is heading toward a new paradigm. Orderly and smooth transition from the current Dollar, debt, and oil-based paradigm is more desirable than its likely crisis-driven alternative.

The Dollar-dominated international financial system has made it very difficult to resist the temptation of risky inflationary monetary and fiscal policies to postpone or avoid recession. Although the return to a pre-WWII gold standard is not warranted, a multi-currency financial system, with a Bretton-Woods III structure to limit trade imbalances, may impose the required discipline. For the U.S. economy, reduction in its trade deficits and external debt would require increasing savings rates to reduce reliance on foreign savings, accompanied with reduction, especially, in fossil-fuel consumption.

Asian and oil-exporting countries that have accumulated large trade surpluses with the U.S. need also to restructure their economies toward long-term sustainable growth, beyond Bretton-Woods II. Higher domestic consumption rates in Asia would reduce the region's dependence on export-oriented growth, and the need to support the Dollar, which has led to cheaper credit and the resulting bubble. An orderly transition would allow those countries to diversify their investment holdings over time, without destroying the value of their current Dollar-denominated holdings in a disruptive manner that can contribute to long-term protectionism and severe global recession.

Oil-exporting countries, especially in the Middle East, need to continue along the path of political, economic, and educational reforms, even as the apparent urgency of such reforms has dissipated in the face of renewed petrodollar flows. Those reforms are necessary to enhance the region's absorptive capacity, thus minimizing the incidence of petrodollar-driven speculative bubbles. They would also reduce disaffected-youth-driven long-term geopolitical risks that amplify the cycle of petrodollar flows.

## 2 Historical Background

Over the past one-and-half centuries, the world has witnessed multiple cyclic episodes of increased globalization on the one hand and trade and financial protectionism on the other. Periods of increased trade and globalization were accompanied by increased demand for energy, resulting in higher oil prices, since supply generally cannot grow in proportion to demand over the short term. High energy prices eventually spur technological innovation and investment in capacity building, resulting in supply growth after a moderate lag. In the meantime, higher energy prices jump-started inflationary pressures that were accelerated as negative real interest rates encouraged further spending growth, further exacerbating the inflationary cycle. Inflationary cycles ended with recessions following currency and/or banking crises. The resulting decline in demand coincided with increased supply, depressing energy prices, thus sowing the seeds of a new boom-and-bust cycle. Figure 1 chronicles the resulting cycle in oil prices through multiple international financial systems over the past 150 years.

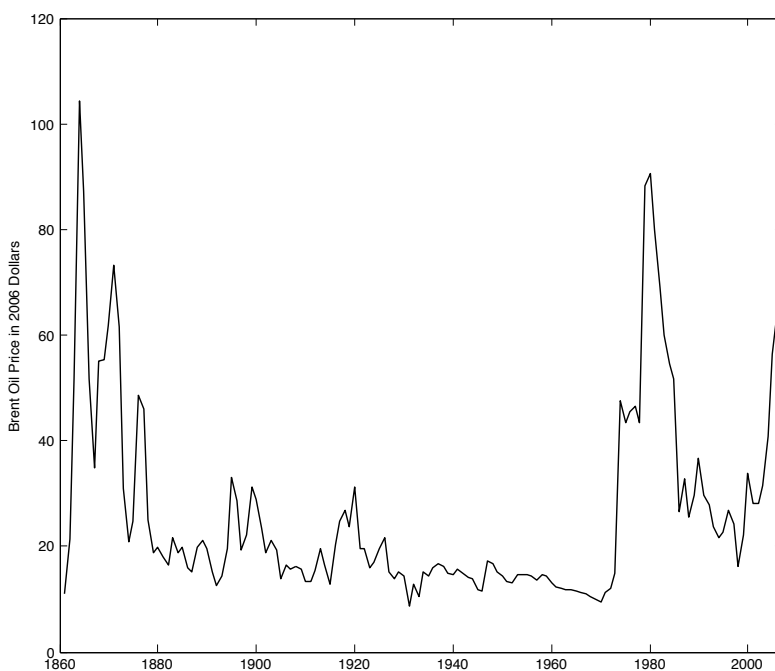


Figure 1: Brent Oil Prices 1860-2008, Constant 2006 \$. Source: BP Statistical Review Database.

The high-oil-price episodes in Figure 1 coincided generally with periods of financial turmoil, accompanied with currency and/or banking crises, in the mid 19th century, around the turn of the previous century, prior to the Great Depression, and after 1973. Other subperiods were characterized by relative calm on the currency and banking fronts, as prudent monetary, financial, and currency-stabilization policies prevented excessive speculation and resulting disruptions. The period 1850 to 1870, when real oil prices exceeded their current levels, was one of the most difficult periods, with numerous currency and banking crises. This rocky episode convinced many of the world's developed economies to abide by a strict gold standard, which resulted in a prolonged period of financial stability in currency and banking crises between 1880 and 1913, and ushered an age of globalization – increased flows of capital and goods worldwide – that only came to tragic end with the advent of World War I.

The period between the two world wars was not only witness to the Great Depression, but also to the breakdown of the international financial system under the gold standard. Numerous banking and currency crises helped to destroy the remnants of the pre-World War I age of globalization, with numerous countries adopting protectionist policies that strangled capital and trade flows. In the aftermath of World War II, the Bretton-Woods accord and enforcement of stricter banking laws, such as the Glass-Steagall act in the United States, brought the international financial system and the banking system to a period of relative calm from 1945 to 1971. Reckless lending bubbles were restricted domestically by the stricter banking laws, and globally by the Bretton-Woods reserve currency system, which acted in a manner similar to the gold standard era before World War I.

Under the gold standard system that prevailed prior to World War I, if some countries had trade deficits for a prolonged period, the outflow of gold from deficit countries to surplus countries reduced the money supply in the former and increased it in the latter. The resulting recessions in the deficit countries reduced the prices of their products, as the inflationary influence of gold inflows increased the prices of the trading-surplus countries. This, in turn, ensured the slowing down and ultimate reversal of trade flows. Similarly, under the Bretton-Woods accord, an outflow of Dollars and reduction of reserves for the countries running consistent trade deficits brought scrutiny of the International Monetary Fund, austerity plans and possible currency devaluation, and eventual correction of trade flows.

Leading up to 1971, the U.S. started to experience rising deficits (in part due to financing the Vietnam misadventure of the 1960s) that raised doubts regarding her ability to maintain the long-standing price of gold at \$35 an ounce, and international financial speculators were already challenging that price. In August 1971, Britain demanded that all of its Dollar reserves, \$3 billion in total, be paid in gold. Two days later, on August 15, 1971, President Nixon abandoned the gold-Dollar link. The Dollar then depreciated multiple times, allowing U.S. exporters to become more competitive once again in international markets. By 1973, the Bretton-Woods monetary system was dead, and the Dollar-prices of commodities, including oil and gold, began to soar. Geopolitical events, such as the infamous Arab oil embargo, might have played a catalytic role, but the fundamentals of renewed high oil prices can be traced back to the new Dollar-centered international financial system.

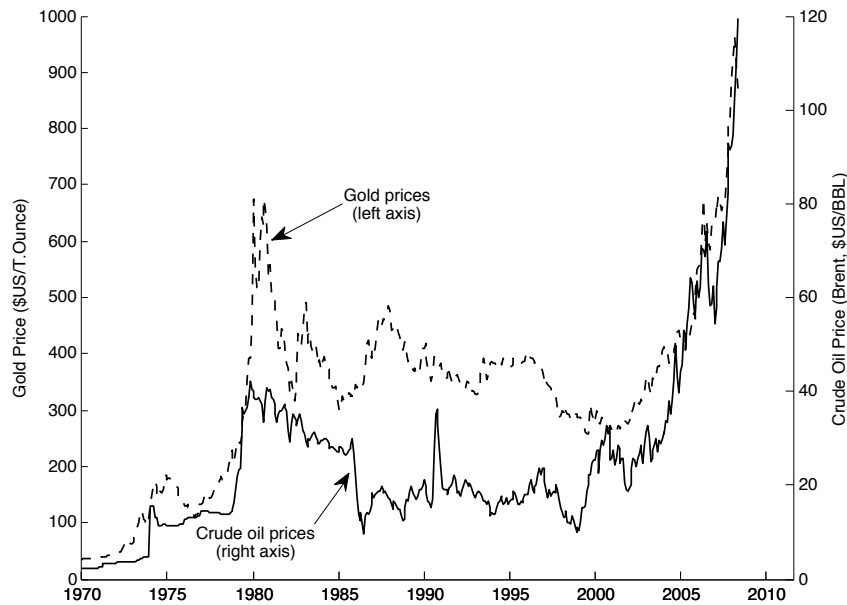


Figure 2: Dollar prices of gold and oil 1970–2008. *Source:* IMF – International Financial Statistics

To make that case, consider oil priced in gold, which was effectively the case under the gold standard and the Bretton-Woods system. We would have expected Dollar-prices of oil to increase steadily after 1971. In fact, however, while the Dollar depreciated and monetary policies allowed inflation in the prices of most commodities, Dollar prices of oil remained remarkably stable, as shown in Figure 2.

The resulting decline in oil prices relative to gold between 1971 and 1973 is illustrated more clearly in Figure 3: Between 1970 and 1973, the gold-price of oil (gold ounces per barrel) had been cut in half. In Fall 1973, the dramatic rise in the Dollar price of oil allowed the gold price to quadruple, overshooting the 1971 level, to which they returned briefly in 1975. Indeed, inspecting Figure 3, we can see that all dramatic jumps in the gold-price of oil were preceded by periods of systematic decline.

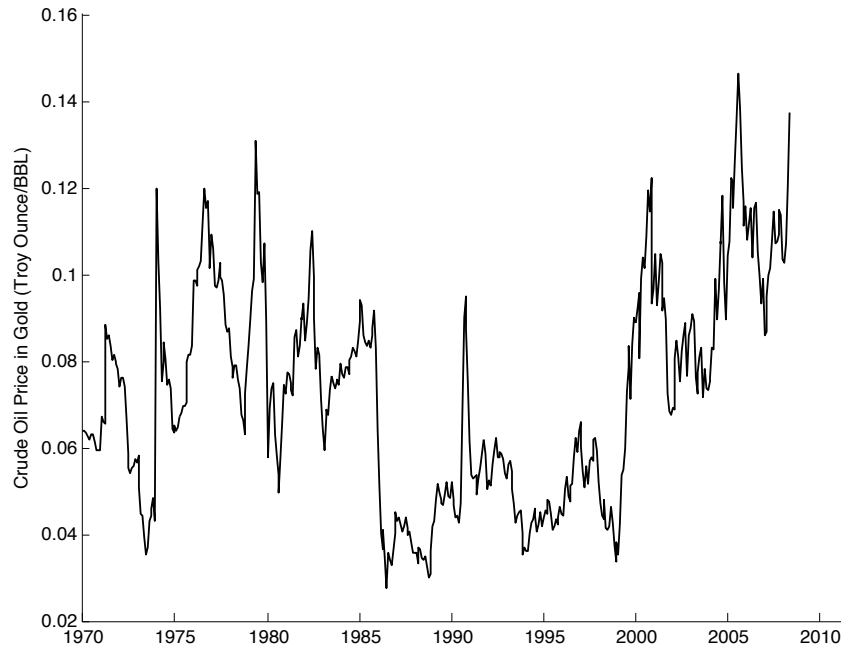


Figure 3: Gold price of crude oil 1970–2008 (Troy ounces/barrel). *Source:* IMF – IFS

It is useful to focus on the first repetition of this pattern before the oil shock of 1979. Inflation in the mid 1970s allowed gold prices to rise faster than oil prices, again cutting the gold price of oil in half between 1976 and 1979, leading to a major correction in oil prices following the Iranian revolution in 1979. The inflation of the 1970s was finally brought to an end when Paul Volker, appointed as Chairman of the Federal Reserve Board by President Carter in August 1979, began a series of dramatic increases in United States interest rates, doubling them from 10% to 20%, and holding them at those extremely high levels until 1982. This drove the United States and world economies into recession, which brought down gold from price levels that it has not revisited until the current inflation.



The two major increases in oil prices during the 1970s coincided with specific historical events: the 1973 Middle-East war, and the 1979 Iranian revolution. In both cases, however, the period preceding the jump in oil prices was characterized by inflationary United States monetary policy, as summarized by the rising price of gold, which continues to be viewed as one of the best venues for hedging inflation risk. In both cases, the gold price of oil overshot its pre-inflation value, but then reverted to its normal levels within a few months. OPEC's reluctance to increase production currently in part reflects their view that high prices owe more to lax U.S. monetary policy than to supply shortage.

The recession of the 1980s and the lack of coordination of OPEC members between the mid 1980s and the late 1990s, depressed the real price of oil for nearly two decades, with the exception of a brief spike in prices due to the Iraqi invasion of Kuwait in 1990. Renewed global economic growth as the century turned coincided with OPEC regaining its ability to coordinate production quotas, thus bringing the real price of oil back to its previous robust level from the late 1970s. The cycle is now repeating itself as the continued decline in the Dollar against other currencies has been reinforced by low-interest-rate policies designed to prevent the United States economy from falling into deep recession under the pressure of mounting debt.

The weak Dollar, together with generally undiminished oil consumption, contribute to the large U.S. trade deficit through the oil-import bill. Lower interest rates were originally necessitated due to the technology stock bubble burst, and the terrorist attacks of September 11, 2001, both of which had contributed to a brief recession early in the decade. The continuation of interest-rate cuts while oil prices were rising, and petrodollars were rushing back into the U.S. economy, fueled another bubble, this time in real estate and esoteric financial instruments. The latter bubble is currently deflating, causing investors to flee to commodities, prices of which have reached unsustainable levels in a feedloop that cannot continue apace forever. As fuel prices rise, the U.S. trade deficit grows, hurting the Dollar, which then causes oil producers to raise oil prices to protect Dollar-denominated revenues, thus putting the U.S. economy under more pressure, and so on. The resulting pattern is bound to end with a drop in real demand for oil, eventually collapsing the entire cycle.

### **3 Energy Prices, Trade Deficits, and the Dollar**

The current energy markets blossomed during the golden age of the Dollar. Hence, despite occasional and isolated attempts to trade oil in barter or for currencies other than the Dollar, the fortunes of oil-exporting countries have been intimately intertwined with the strength of the Dollar. However, as the Dollar has continued to weaken against other currencies, those countries' Dollar-denominated oil receipts and currency reserves have continued to depreciate. The declining real value of the Dollar has prompted Gulf Cooperation Council (GCC) and other OPEC countries to resist calls to increase their production quotas. In addition, Kuwait, a country that is very friendly to the United States, has removed her currency's peg to the Dollar in May 2007, as Venezuela, significantly less friendly to the U.S., has been urging OPEC members to stop selling oil for Dollars. In the meantime, many countries, friendly and unfriendly to the U.S., have begun to protect their wealth by diversifying reserves and investments, in part through sovereign wealth funds' strategies, away from Dollar-denominated assets.

There is no doubt, historically, that the denomination of energy prices in Dollars has been a complicated issue, with many consequences for energy and financial markets. Pricing oil in Dollars was natural under the Bretton-Woods system 1945-1971. Shortly after the first oil shock of 1973, Secretary of State Henry Kissinger orchestrated a system for petrodollar recycling, which featured most prominently the agreement that oil would continue to be priced in Dollars, even as the latter began to depreciate relative to other currencies starting in 1971. Major OPEC countries, especially Saudi Arabia, were also given incentives to continue extracting oil and selling it for Dollars, by providing investment opportunities for their petrodollars in Dollar-denominated assets and debt instruments such as federal bonds and FNMA (Fannie Mae) mortgage-backed securities.

As long as large portions of oil-exporting countries' assets remain invested in Dollar-denominated assets, and as long as the United States continues to play an important geopolitical role in safeguarding many of those countries, oil exporters continue to have every incentive to support the Dollar by pricing their exports in the currency. Therefore, despite short episodes when some countries such as Russia, Iran, Venezuela, and Iraq, preferred to sell their oil for Euros or in barter, the Dollar-denomination of the oil market has continued generally unchallenged. With the growth of U.S. debt, not only to

oil-exporting countries, but also most prominently to Japan, China, and Korea, those large creditors of the United States are now contemplating how they can find a soft transition from the current situation.

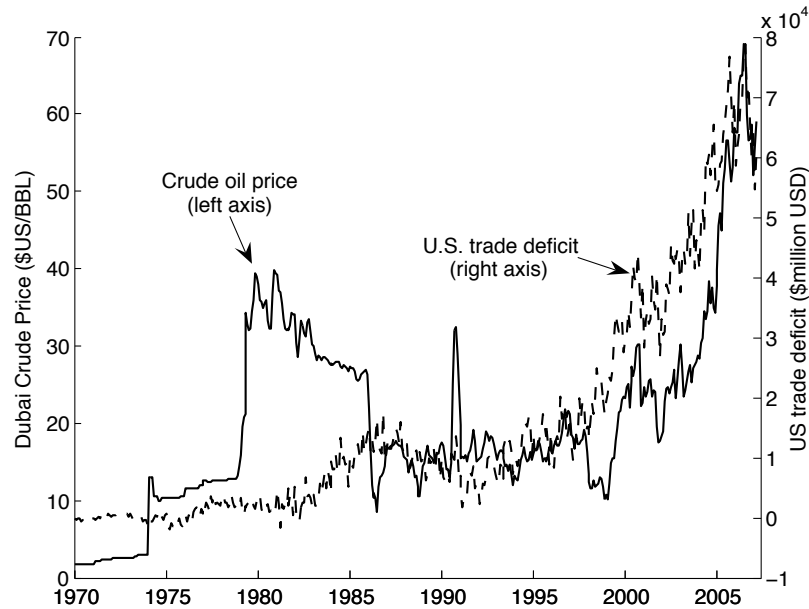


Figure 4: Crude prices and U.S. monthly trade deficit. *Source:* IMF, IFS and OECD

In the meantime, the current high-oil-price scenario continues to put pressure on the Dollar, especially since the U.S. currently imports more than 60% of its oil consumption, to the tune of \$400 billion projected in 2008, through mounting trade deficits and debts. The Dollar is thus caught in a vicious circle: high oil prices feed U.S. trade deficits, leading to increased U.S. indebtedness and a weaker Dollar, which further leads to higher oil prices. A natural solution would be to increase interest rates in the U.S., to support the Dollar financially, and simultaneously to improve the U.S. balance of trade. However, given the series of bubbles in U.S. financial markets, an increase in interest rates can have devastating effects on financial markets and the economy more generally. A sudden collapse in financial markets, or a sudden collapse of the Dollar, would be catastrophic for the global economy, wherein U.S. expenditure and financial markets continue to play dominant roles.

## 4 Credit Bubbles

The roots of the current episode of globalization can be found in the early 1970s. “There was great irony,” Volker said, that “people were more willing to hold dollars that weren’t backed by gold than they ever were willing to hold dollars that were backed by gold” (Karmin, p.100). With the ability to print money at will, higher rates of global growth were possible, even as the risk of financial meltdown increased substantially. As we can see in Figure 5, flows of debt financing in the 1970s set the stage for later waves of foreign direct investment and portfolio investment in developing countries, or emerging markets as they came to be known. When the Bretton-Woods system came to an end in 1971, the world started on an inflationary spiral that was exacerbated by the sharp increases in oil prices in 1973 and 1979.

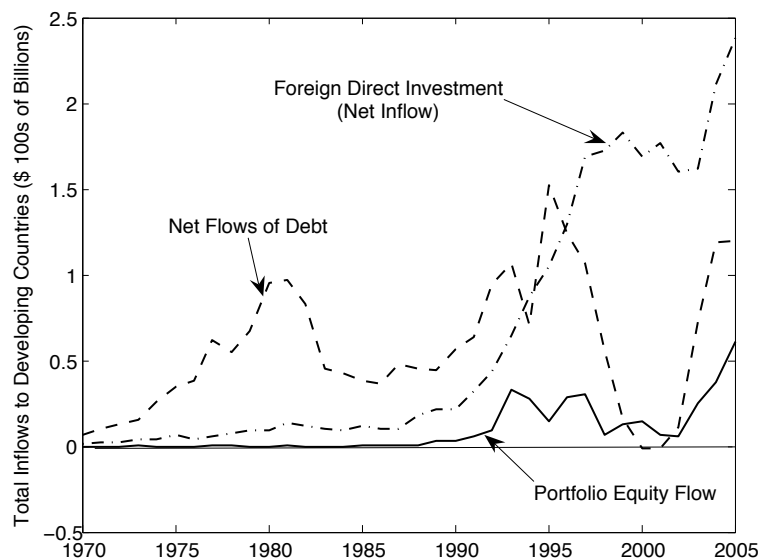


Figure 5: Foreign Direct Investment, Portfolio, and Debt flows to Developing Countries (US\$ Hundreds of Billions). *Source:* World Bank, Global Development Finance.

As the United States’ trade deficit with oil exporting countries increased following October 1973, Secretary of State Henry Kissinger and Secretary of Treasury George Schultz designed a system of recycling the petrodollars that flowed into Saudi Arabia and other major oil exporters. Those petrodollars

were invested in Dollar-denominated assets or deposited in New York banks, which, in turn, lent them to other countries that were running trade deficits. High inflation and an accommodating monetary policy meant that real interest rates were very low, even negative, for many years, which encouraged many developing countries to seek more debt – a demand that banks flush with cash were happy to accommodate. As we can see in Figure 6, the bulk of this debt went to middle-income countries, many of which were themselves oil exporters – mainly in Latin America – that sought to accelerate their industrialization by borrowing against then-valuable oil reserves. This debt-inflationary episode ended badly with the 1980s debt crisis in Latin America. Imprudent lending has also played a central role in the financial crises that transpired in the mid-1990s, in Asia, Latin America, and Russia. Lower interest rates have allowed the international financial system to weather those and other recent storms, but have also contributed to the biggest credit bubble of all: that of U.S. debt and the depreciating Dollar.

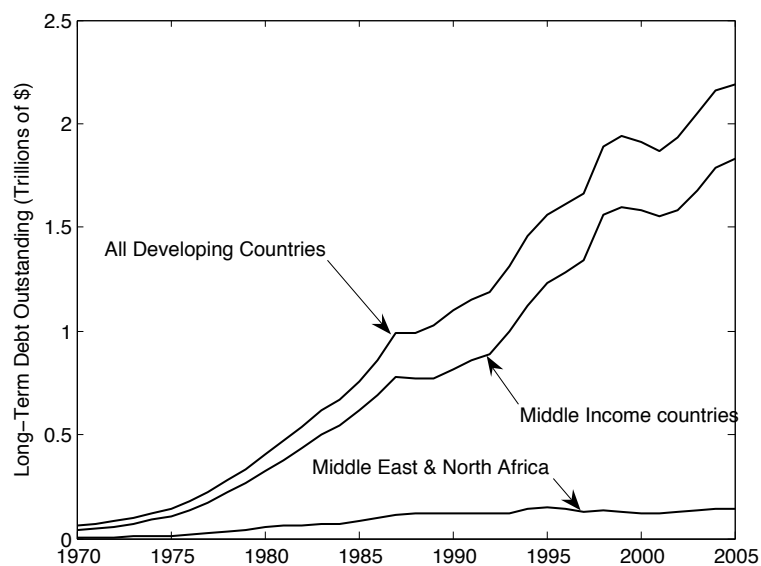


Figure 6: Long-Term Debt Outstanding (in Trillions of Dollars). *Source:* World Bank, GDF.

The earlier debt-inflation cycle of the 1970s-80s did not end well for countries that had accumulated large amounts of debt, or for the bankers and the Middle-East investors who had extended that credit. When the Chairman of the Federal Reserve Board Paul Volker raised interest rates during the

period 1979-82, in order to combat run-away inflation, the Dollar-denominated debt servicing costs became prohibitive. In addition, the global recession that ensued resulted in reduced demand for the exports of those indebted countries, just as banks were becoming naturally reluctant to extend any more loans. The flow of credit to those countries thus slowed down during the early 1980s, as shown in Figure 5, but then recovered by the mid-1990s leading into the Asian crisis of the late 1990s.

The credit boom of the 1970s led the way for other financial avenues of globalization. Prior to the 1970s, two world wars were followed by a wave of independence movements around the world. This put an end to the global economy of the late nineteenth and early twentieth centuries. Most developing countries were seeking to industrialize during the 1960s through import-substitution and other planned-economy – often socialist – policies. This made the developing world less hospitable to foreign direct investment by multinational corporations, let alone to portfolio investment.

At the same time, obvious moral hazard problems discouraged advanced economies from investing directly in countries that might nationalize their capital or prevent repatriation of profits. Loans to sovereign states were seen thus as safer means of investing in emerging markets, because, as Citicorp Chairman Walter Wriston put it: “Countries don’t go out of business.” Over the years, moral hazard was reduced as those countries abandoned import substitution policies and – at the encouragement of the IMF and the World Bank – adopted legal and financial reforms, which helped to alleviate their debt problems, but also helped to protect the interests of foreign direct and portfolio investors. As a consequence, those emerging markets became more hospitable and attractive for foreign direct investment, which overtook debt financing as the main source of foreign investment by the mid 1990s. During the ensuing decade, globalization grew into its current form, allowing not only easier global transfer of goods, services, and finance, but also the global contagion of financial crises and resource curses, including the Middle East’s curse of black gold.

Petrodollar flows, the financial manifestation of the Middle-East’s resource curse, have returned to center stage in contributing to the current credit bubble. Some may argue that the importance of recycled petrodollars is lower today than it was during the 1970s and early 1980s. They point primarily to China as a main source of global financial flows. Indeed, the importance of Chinese outflows cannot

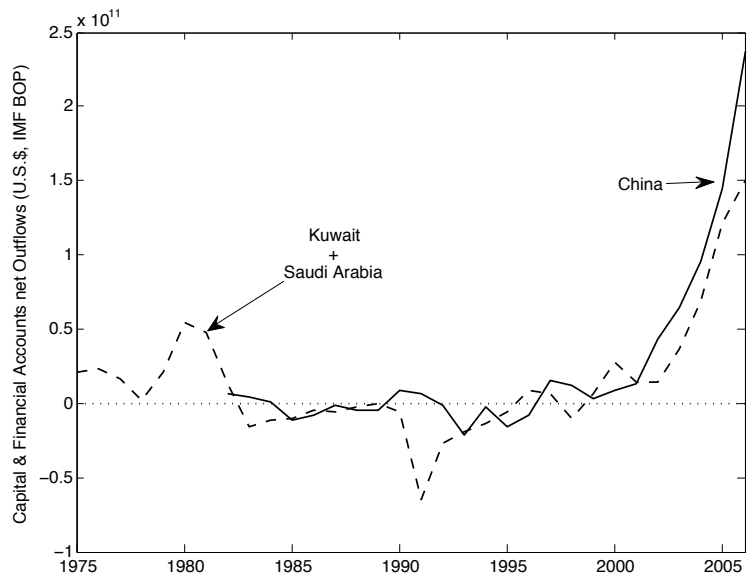


Figure 7: Chinese vs. Middle-East Capital & Financial Outflows. *Source:* IMF, BOP.

be exaggerated. However, the current role of recycled Middle-East petrodollars should equally not be minimized. While the flow of Chinese transnational capital has been ongoing, the acceleration in asset bubbles and worsening of financial crises have been in large part driven by the petrodollar boom that began to take shape after 2003. Figure 7 compares the net capital and financial account outflows from mainland China with the outflows from Saudi Arabia and Kuwait alone. The Figure shows that the outflows from these two GCC countries rivaled those of China until 2006, and likely have accelerated further as oil prices have spiked more recently. Moreover, the total stock of Middle-East petrodollars invested outside the region may exceed China's due to earlier accumulations in the 1970s and early 1980s. It is also important to note that China's and other countries' economies have substantially higher absorptive capacities than GCC countries, whose real estate and stock market bubbles have tested the limits of domestic recycling of petrodollars. Some Gulf states (e.g. the emirate of Abu Dhabi) are reportedly starting to earn more on their sovereign wealth funds' investments than they earn from oil sales. Thus, the nature and effects of petrodollar flows are likely to play a central role in international financial markets, and any potential crisis therein.

## 5 Contagion

Starting in the mid 1990s, the possibility of financial contagion – the process through which instability in one financial market can affect another – began to rattle global finance. A string of financial crises that started in the second half of the 1990s lent credibility to the contagion hypothesis. The problem started with the Asian crisis, then the crisis of Russian default, followed in few years by Turkish and Brazilian financial crises. During the decade 1995 to 2005, the contagion hypothesis continued to gain momentum, as crises in one country’s currency (e.g. Thailand) or stock market quickly spread to other emerging markets, and ultimately to advanced economies – as the Long Term Capital Management crisis in the United States showed. In more recent years, the credit bubbles driven by recycled petrodollars and Asian-country trade surplus Dollars has likewise depressed interest rates and allowed a credit bubble to start in the United States, most notably in the esoteric area of subprime mortgages and asset-backed securitization, but then the resulting crises spread around the world.

There are many ways to measure contagion, including the spread of volatility from one market to another. However, studying contagion only in terms of volatility masks the asymmetric results of contagion as well as important dangers in today’s financial markets. In traditional financial measurement of risk with volatility, the worst effects of contagion would be high levels of correlation between markets, with considerable loss of diversification effects. In the late 1990s, this would have translated into increased risk as hedge fund managers and other large investors, who had assumed that they reduced risks by investing simultaneously in a number of emerging markets in Asia, Eastern Europe, and Latin America, discovered that those markets in effect moved together. Indeed, the investment behavior of those large investors, and their decision to withdraw their investments from all emerging markets following a crisis in one such market, may have induced those correlations where none had existed previously.

In this paper, we shall illustrate contagion from the point of view of extreme negative comovements. This approach is superior to the more traditional correlation analysis, since correlations focus on small linear comovements near the average rates of return, whereas today’s large investors, including sovereign wealth funds, hedge funds, etc. are mostly concerned with substantial comovements that can destroy



significant amounts of accumulated wealth. Within this context, as we shall demonstrate shortly, it is possible not only for diversification effects to vanish, but also for contagion to induce substantially higher risk of extreme losses for more apparently “diversified” portfolios.

Consider the following scenario: We have two types of crisis months for country A’s economy, currency, or stock market. In the first type of crisis months, countries A and B are simultaneously affected by the same extreme risk factors and experience simultaneous crises. In the second type of crisis months, countries A and C are simultaneously affected by the same extreme risk factors and experience simultaneous crises. If investors in country A’s economy diversify their risk by investing only in country B alone or country C alone, they would be exposed to extreme comovement risks only under one type of crisis months. However, if they diversify by investing in all three countries simultaneously, then they will be exposed to both types of crisis months, and possibly have negative diversification effects, which is not possible under the traditional correlation analysis.

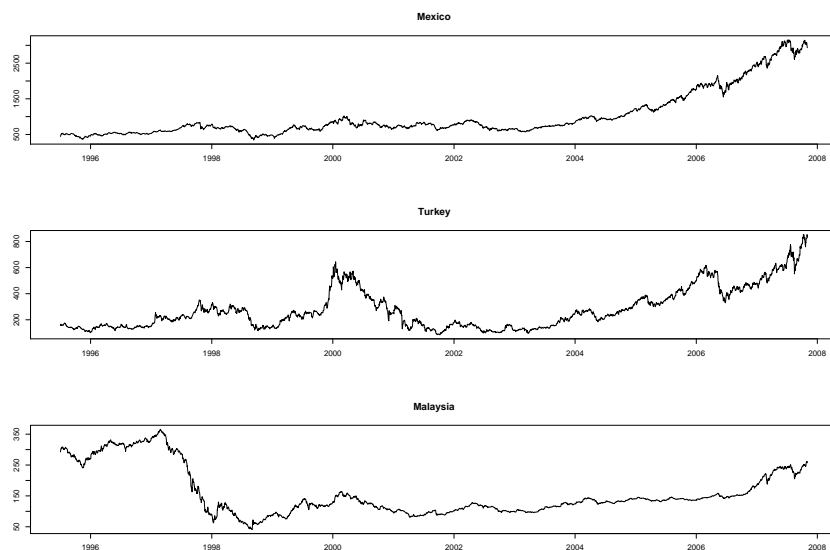


Figure 8: Stock Market Indices. *Source:* S&P/IFC data.

For a concrete analysis, consider the three stock indices of Mexico, Turkey, and Malaysia over the period July 1995 to December 2007, which covers the various crises listed above. The time series of

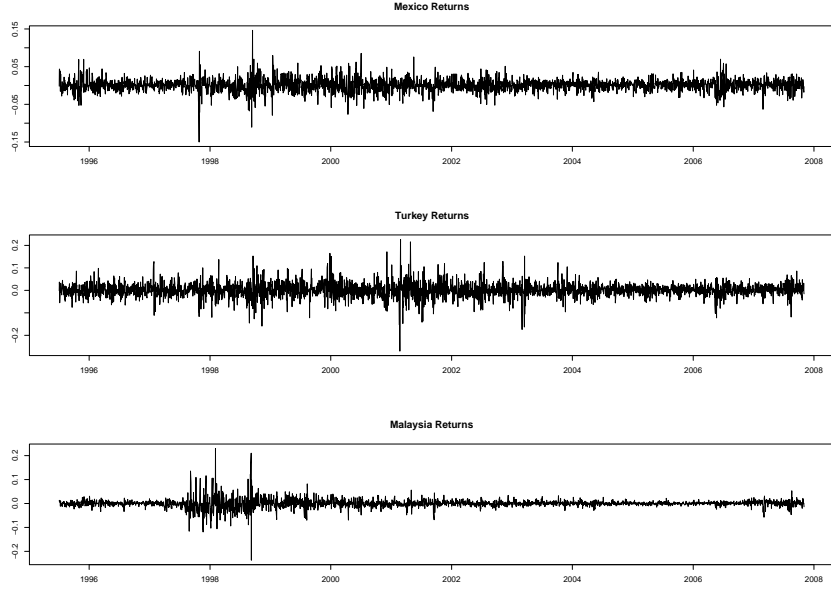


Figure 9: Stock Market Index Returns. *Source:* S&P/IFC data.

the three series are shown in Figure 8 and the corresponding return series are shown in Figure 9.

## 6 Contagion and Negative Diversification Using Extreme Value Theory

We can readily see in Figures 8 and 9 that some periods were characterized by large losses in Mexico and Malaysia, but not in Turkey (e.g. 1999), while other periods were characterized by extreme comovements of other combinations of the countries' indices. For each of the three return series for the three countries, we fit a Generalized Pareto Distribution to negative returns exceeding a given threshold.<sup>1</sup> In particular, we allow the distribution of negative returns below that threshold to be estimated using the empirical distribution function, and fit a Generalized Pareto Distribution's parameters to the "tail" observations above that threshold. Formally, we model the distribution of negative returns as:

$$F_X(x) = \begin{cases} F_n(x) & \text{if } x < u_x \\ 1 - (1 - F_n(u_x)) \left( 1 + \frac{\xi_x(x - u_x)}{\sigma_x} \right)^{-1/\xi_x} & \text{if } x \geq u_x \end{cases}$$

<sup>1</sup>We thank Ibrahim Ergen for his able research assistance in producing the results in this section, which generalizes slightly the framework of Poon et al (2004).

Next, we convert the distributions of all of the negative returns above the threshold to unit Frechet through the transformation  $S = -1/\log F_X(x)$ . This makes the probability of the transformed negative returns exceeding any given value inversely proportional to that value:  $\Pr\{S > \tau\} \approx 1/\tau$ . For any pair of transformed negative returns for two indices, we can measure the dependence structure with the probability that losses (negative returns) simultaneously exceeds a particular quantile  $q$  of the transformed unit Frechet variables:  $P(q) = \Pr\{F(T) > q | F(S) > q\}$ , whereby  $P(q) > 0$  implies a positive dependence structure at quantile  $q$ , and vice versa. If we assume that the returns are independent and identically distributed, then we can use the Poon et al. (*Review of Financial Studies*, 2004) approach to study the dependence structure using one or both of the following two measures:

$$\chi = \lim_{q \uparrow 1} P(q) = \lim_{q \uparrow 1} \frac{\Pr\{F(T) > q, F(S) > q\}}{\Pr\{F(S) > q\}}$$

$$\bar{\chi} = \lim_{s \uparrow \infty} \frac{2 \log \Pr\{S > s\}}{\log \Pr\{S > s, T > s\}} - 1$$

If the estimated  $\chi = 0$ , then we conclude that the two series are asymptotically independent, as  $q \uparrow \infty$ . In other words, we would conclude that extremely large losses in one series are not generally accompanied by extremely large losses in the other. If we fail to reject that  $\chi = 0$ , then we measure the amount of dependence by  $\bar{\chi}$ . Otherwise, if we fail to reject that  $\bar{\chi} = 1$ , then we conclude that  $\chi > 0$  and the two series are asymptotically dependent, meaning that extreme losses in one series, no matter how large, are very likely to be accompanied by equally-extremely-large losses in the other. The type and degree of asymptotic extreme dependence in this case is measured by the estimated value of  $\chi$ .

In this regard, the estimate  $\chi$  and  $\bar{\chi}$ , and their estimated standard errors, are obtained by noting that the minimum of two standard Frechet random variables is itself unit Frechet (this is the driving insight behind the approach of Poon et. al), yielding the following estimates:

$$\hat{\bar{\chi}} = \frac{2}{n_u} \left( \sum_{i=1}^{n_u} \log(z_{(i)}/u) \right) - 1; \quad \text{var}(\hat{\bar{\chi}}) = (\hat{\bar{\chi}} + 1)^2/n_u$$

$$\hat{\chi} = \frac{un_u}{n}; \quad \text{var}(\hat{\chi}) = \frac{u^2 n_u (n - n_u)}{n^3}$$

The suggested procedure of Poon et. al is first to estimate  $\bar{\chi}$  and to test if it is equal to 1. If we reject that  $\bar{\chi} = 1$ , then we essentially accept that  $\chi = 0$ , and use the estimated  $\bar{\chi}$  to measure extremal (but

non-asymptotic) dependence. Otherwise, if we fail to reject that  $\bar{\chi} = 1$ , then we estimate  $\chi > 0$  as our measure of asymptotic extreme dependence. In Figure 10, we plot the estimated  $\bar{\chi}$  for the Mexican index's losses with losses of the various portfolios of Turkish and Malaysian indices.

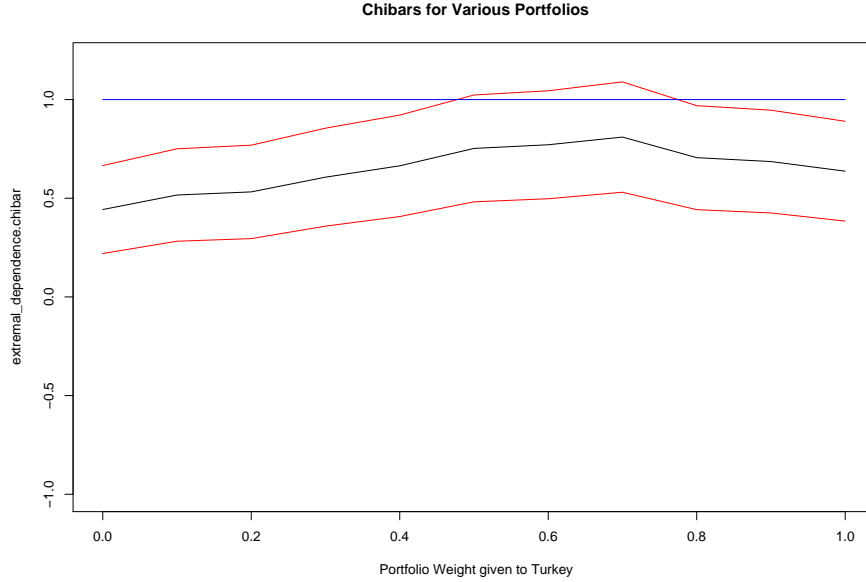


Figure 10: Estimated  $\bar{\chi}$  for portfolios of developing-country stock indices.

The estimated  $\bar{\chi}$  for each portfolio mix is plotted in black, with the red lines showing a 95% confidence interval around the estimate. The plot in Figure 10 suggests that Mexican index losses were not asymptotically extremely dependent with either the Malaysian index losses or the Turkish index losses by themselves. However, the graph suggests that a mix of around 60% Turkish and 40% Malaysian stocks would be extremely dependent with the Mexican index. In other words, investing in all three not only fails to bring diversification effects, but actually causes negative “diversification” effects by increasing the portfolio’s exposure to extreme losses under a larger number of implicit scenarios.

This asymptotic extreme dependence result is in fact a bit exaggerated by the assumption of independent and identically distributed return series for the three indices. We also estimate a model for the

returns to follow an AR(1) process with GARCH(1,1) conditional variance process:

$$r_t = \beta_1 + \beta_2 r_{t-1} + \sigma_t Z_t, \quad \text{with } Z_t \stackrel{i.i.d.}{\sim} N(0, 1), \quad \text{and}$$

$$\sigma_t^2 = \gamma + \delta U_{t-1}^2 + \lambda \sigma_{t-1}^2.$$

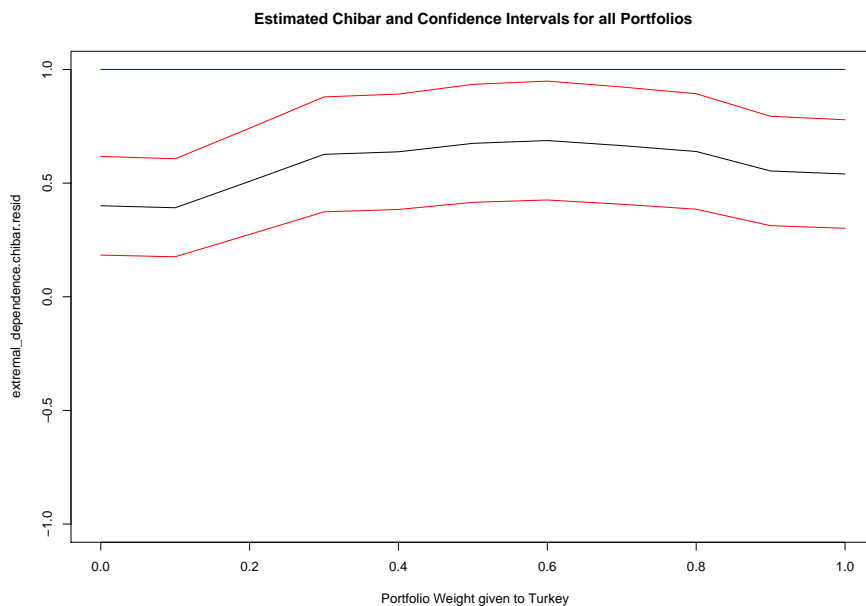


Figure 11: Estimated  $\bar{\chi}$  for portfolios of developing-country stock indices, fitted to GARCH residuals.

The resulting estimates of  $\bar{\chi}$  for the residuals from this AR/GARCH model is as shown in Figure 11. Allowing for the more complex model of persistence in returns and in the volatility of returns, we no longer can find any portfolio of Turkish and Malaysian indices the returns of which are asymptotically extremely dependent with the Mexican index returns. Therefore, for this model, we conclude that  $\chi = 0$  for all such portfolios. However, it is still true in this case that the  $\bar{\chi}$  estimate of extreme (albeit non-asymptotic) dependence between the indices is still much stronger for “more diversified” portfolios than for less diversified ones. We still obtain the same counter-intuitive conclusion, therefore, that increased diversification may in fact increase rather than reduce exposure to extreme losses. In fact, this general trend for extremal comovements of various stock indices has become increasingly pronounced

over the past decade, exacerbated in great part by the similarities in investment strategies among large investors, which have tended to pursue and withdraw from various markets simultaneously. This increased contagion will thus play a central role in any global financial crisis.

## **7 Energy, Contagion, the Dollar, and the International Financial System**

Thus, we have come full circle: Various aspects of the 1970s energy crisis, and the ensuing financial crises of the 1980s are currently influencing financial markets. In addition, many of the factors that prompted global rewriting of the international financial system in the late nineteenth century, between the two world wars, and following World War II, appear again to be in full force. The globalization phase that started with decoupling the U.S. Dollar from gold in the 1970s has not only matched, but exceeded the level of globalization prior to World War I, but without the earlier discipline of the gold standard. Run-away trade and fiscal deficits, and resulting credit and asset bubbles, are currently in full swing, and the risks of global financial crises are amplified by the increased levels of financial integration and contagion. The natural questions to ask at this stage are: (1) what developments may prompt a global financial crisis, and (2) how the global financial system may be affected by such a crisis?

We think that energy markets may play an important role in bringing about a financial crisis that may transform the global financial system. The economic story underlying this general scenario is quite simple, and reminiscent of what we have previously observed, most recently in the 1970s and 1980s. The current episode of high energy prices is highly unlikely to continue unchecked for more than a decade, as some observers have suggested. The high prices have been supported by high levels of demand not only from the fast-growing China and India, but also from sustained growth rates in the developed world, most notably the United States and (more recently) the European Union.

Petrodollar recycling from energy exporters, whose economies are incapable of absorbing those receipts, has combined with the trade surpluses of Asian exporters of manufacturing and service-sector goods to fuel speculative bubbles and price inflation worldwide. To-date, central bankers in the United States and Europe have helped to maintain the status quo by keeping interest rates low – hoping to avoid a deep recession. However, as inflationary pressures mount, it is inevitable that the current

atmosphere of accommodating monetary and fiscal policies will have to come to an end. The eventual increase in cost of funds will combine with high energy prices to reduce economic growth and reduce the rate of growth of demand for oil, as the relationship depicted in Figure 12 suggests.

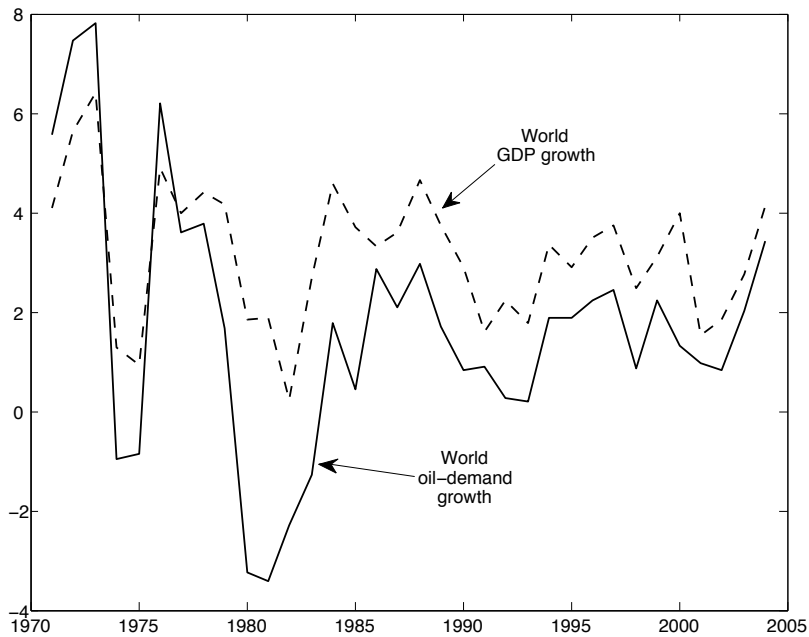


Figure 12: Percentage Growth in World GDP and World Demand for Oil

Forecasts of continued growth in China and India, which would save the world from a global recession, seem highly optimistic, since those economies' growth is primarily export-driven. Turning their attention to growing domestic markets may soften the global blow, but would be highly unlikely to save the world from recession, or to save energy markets from decreasing demand. Moreover, the Chinese banking and financial systems, in particular, are quite vulnerable to crashes and crises as reduction in economic growth is likely to reveal large portfolios of bad loans in the system, which are currently masked by economic growth and credit extension. Japan's banking crisis is a good reminder of what could happen in China as growth rates begin to decline. A banking crisis of the same magnitude as Japan's would require massive rescue packages, costing well above \$1 trillion and requiring massive sale of Dollar-denominated assets, thus deepening the crisis. However, it is the nature of such bank-

ing crises that they are very difficult to anticipate. Consequently, most oil-demand forecasts continue to suggest robust growth in the emerging economies that would more than compensate for already declining demand in OECD countries.

The eventual reduction in global demand for energy, if a global recession materializes, is likely to coincide with increased production capacity in hydrocarbon fuels, as well as continued advances and increased economy in the use of alternative fuels. The full battery of supply and demand factors would thus serve to depress energy prices and stop the flow of recycled petrodollars. Cessation of cheap credit from recycled petrodollars and Asian export receipts would thus impact the growth rates of advanced economies further, and help to deepen the cycle phase of global recession and lower energy prices.

In the process, the status of the U.S. Dollar as the unique global reserve currency, a status that has generally survived both the Bretton-Woods years of 1945-1971 and the globalization period that ensued since the 1970s, would likely come to an end. Academic researchers such as Barry Eichengreen, political historians such as Kevin Phillips, and star traders such as George Soros, all seem to agree that the Dollar era is near its end. We have already begun to observe several countries removing their currency pegs to the Dollar, and diversifying away from Dollar-denominated assets, either directly by investing some new export receipts in different assets, or indirectly through the investment choices of sovereign wealth funds that are seeking globally-diversified portfolios.

## **8 Policy Implications**

Our analysis in this paper has been qualitative on purpose. The temptation to make numerical forecasts notwithstanding, results in this area are heavily dependent on assumptions about demand and supply elasticity, as well as a number of political considerations. Although supply elasticity may be easier to quantify technically, there are numerous considerations, such as OPEC's ability to retain its oligopolistic power, or the potential for military altercations in the Gulf, which are impossible to predict in any statistically-meaningful way. Demand elasticity is also subject not only to technological constraints, but also to numerous political and protectionist/mercantilist considerations that are equally impossible to anticipate.



Because of those and other difficulties, we refrain from engaging in the increasingly popular but nonetheless speculative exercise of predicting whether oil in 2009 will be below \$80 per barrel or above \$200 per barrel. What we can predict in the medium to long-term, however, which may materialize earlier, is that (1) the era of Dollar dominance in financial markets is near its end, (2) the cycle of oil prices will continue, driven by business and construction cycles, and (3) the growth paths of India, and especially China, cannot continue without the financial and business-cycle crashes that other fast-growing economies have experienced throughout history. To the extent that the world will continue to depend on hydrocarbon fuels, especially Middle-East oil, for the foreseeable future, the region's geopolitics will continue to play a central role as a wild card, at times amplifying cyclical trends (as we are witnessing today), and at other times playing a counter-cyclical role.

On the Dollar front, there are many reasons to believe that a smooth transition to a multiple-currency regime, within which the Dollar continues to play an important role, would be desirable. First among those is the fact that most countries continue to hold the bulk of their foreign reserves in Dollar-denominated assets. In order for those countries to avoid seeing their assets depreciate precipitously, they are likely to cooperate on finding a transition path that weans the United States from foreign credit (as well as foreign oil) and weans the emerging economies from excessive export-oriented dependence on U.S. consumption. This would require coordination to reduce savings rates in Asian economies, in order to increase their absorptive capacities, without reducing investment and growth substantially. It would also require systematic reduction of the U.S. current account deficit through increased saving. The lax regulatory environment that encourages speculative behavior, and rewards the most risk-seeking financial speculators with government-orchestrated bailouts, must also be reversed. A stable global financial system will still require a strong Dollar to be a reliable currency, which is impossible in the current environment where unregulated financial players have the ability to create massive amounts of money and to trade in derivative financial products so complex even the originators cannot evaluate their ultimate value or the exposure they have created.

The unregulated creation of credit bubbles, perhaps more than any other factor, has the strongest potential for driving sudden and cataclysmic crises. Regulatory initiative is impossible during times of

crisis, and politically unpopular after crises are weathered. However, the ability to weather one crisis after the next through cheap-money creation only increases the chances for systemic failure, in part by exacerbating moral hazard problems through incentivizing the riskiest speculators to become “too big to fail.” Political foresight is necessary to introduce proper financial regulation in tranquil times, in order to avoid greater crises in the future. The same logic has been gaining traction in the area of environmental and energy-consumption regulation, and the petrodollar link identified above suggests that both sets of regulation should proceed hand-in-hand.

In the meantime, it is important to find means to increase the long-term absorptive capacities of energy-exporting countries through investment in the appropriate forms of human and physical capital to absorb the impending demographic “youth bulge” and diversify away from their dependence on oil-and-gas exports. Those Middle-East countries have succeeded in reducing illiteracy substantially, but their investments in education beyond the elementary level have generally failed to produce workforces that are appropriate for their stage of economic development. An unfortunate byproduct of renewed petrodollar flows to the Middle East has been the suspension and/or reversal of political and educational reforms that had begun to take shape. As the latest trips of President Bush to the Middle East have made very clear, the region is convinced that it can attain economic growth without implementing any fundamental political or education reforms. Thus, the hubris of the 1970s and early 1980s has returned to the Middle East in full force.

Ironically, the increased petrodollar flows, together with fiscal budgeting that assumes significantly lower oil prices, has given regional governments the discretionary funds to reduce geopolitical risk, through tighter security and the financial means to mollify disgruntled youth. This trend plays a counter-cyclical role during the current phase of high energy prices, by reducing the risk of supply disruptions. One must be wary, however, of another generation of petrodollar beneficiaries growing up with unrealistically raised economic expectations, as had happened to the previous generation that was raised in the 1970s. The current wave of petrodollars are in part used to diversify the region’s holdings through acquisitions of companies and importation of technology. However, those trends may not have the desired transformative effect unless education and the business environment are reformed to enable

indigenous entrepreneurship to thrive. Without such transformation, the region's ability to absorb petrodollars and convert them into long-term economic growth would not be better in this wave of the cycle than it was in the last. Given environmental considerations that may affect long-term trends in energy consumption, this may be the region's last opportunity to invest their mineral resources wisely. Wise investment would require removing price distortions through local fuel subsidies, which may favor the acquisition and development of less-than-ideal industries for the region's long-term prospects.

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